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At page 67, after the last line, add, When the direction of rotation of the fraction and its reciprocal are in opposite senses, the reciprocal of the axis is the axis of the reciprocal, as may be shown by equation (9).

At page 69, lines 7 and 8, expunge the sentence "As a versor it implies that β has been turned from some arbitrary direction into the given one."; for it conflicts with the definition given by Hamilton, which is "$U\beta$ is *the versor of a right quotient*." (Elements, p. 136.)

At page 70, line 3, for "has a fixed position," read, is confined to one plane.

Also, at page 68, line 3, for "$i \div - i$" read, $-i \div i$; and at page 71, line 16, for "$-kij = -ijk = -jki$" read, $-kij = -ikj = -jik$.

[Prof. Wood proposes to discuss some examples illustrating the foregoing principles, which will appear in future Nos., as space will permit.]

A FOURTH PROPORTIONAL.

BY JESSE APPLEGATE, YONCALLA, OREGON.

If a straight line, ABC, be considered as composed of two parts, a and b, or the line a be laid upon the line b, the lines a and b, in neither case, form an angle at B, for the lines a and b are *extended* in a line with each other, and their relation to each other at their junction B, would be expressed as an angle of 180°, or a right line. In the second case, as the line a coincides with the line b, the angle at B may be represented by 0°.

Whatever the lengths of the lines a and b may be, a *proportion* exists of which a and b are the means, and their sum $a + b$, one of the extremes. That is,

$$a + b : b = a : x,$$

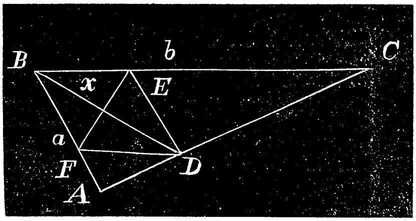
whence

$$x = \frac{ab}{a + b},$$

x being the 4th proportional.

In the above cases, where a and b form a straight line, the 4th proportional depends on the *lengths* of the lines only, it will therefore also exist whatever *angle* these lines make with each other, from 180° to 0°.

To ascertain the utility, if there be any, in the 4th proportional; let the point B be the apex, and carry the line a around until it coincides with the line b, stopping at any point, say at 90°, or before or after passing 90°, to inquire what value the 4th proportional may have in solving problems in Geometry and Trigonometry.



Draw BD bisecting the angle B; also draw DE and DF, respectively parallel to AB and BC. Then will $BEDF$ be an equilateral quadrilateral of which BD and EF are diagonals.

Let x represent the side of this quadrilateral. Then by similar trian.

$$(b-x):x=b:a;\ \therefore\ ab-ax=bx, \text{ or } ax+bx=ab;$$

$$\therefore x=\frac{ab}{a+b},$$

which is the equation of the 4th proport'l existing between the lines a and b.

As the sides of a quadrilateral equilateral can be ascertained from the sides of the included angle, the diagonals of which are the measures of the angle, not by the degrees of an imaginary arc but by actual latitude and departure, two sides of a triangle with any data from which one of these diagonals may be determined, the unknown side and all other things about the triangle may be determined. That is, it solves all the cases of plane Trigonometry by measurement only, without the use of a table.

This method suggests a cheap and simple instrument for the field that would do all the work of the transit more simply and with equal accuracy. And for the observatory, where the quadrangle might be of any desir'd size, the latitude and departure to the $\frac{1}{100}$ part of every second in the semicircle might be read from the diagonals without the necessity of a single calcul'n.

SOLUTION OF PROB'S IN NO. 2; CONTINUED FROM P. 103.

306. "If N is an odd number and m the number of odd numbers less than N and prime to it (including 1), then N is a divisor of one of the two numbers $2^m \pm 1$."

SOLUTION BY PROF. WM. WOOLSEY JOHNSON.

The number of odd numbers less than and prime to an odd number is one half of the whole number of numbers less than and prime to the given number; for, corresponding to every odd number r less than and prime to N, there is an even number $N-r$, also less than and prime to N. Hence $\varphi(N)$ denoting this whole number, the theorem is that when N is odd either

$$2^{\frac{1}{2}\phi(N)}-1 \qquad \text{or} \quad 2^{\frac{1}{2}\phi(N)}+1$$

is divisible by N. But the theorem may be generalized thus, *If a is prime to N, one of the quantities*